MEASURES OF JOB FLOW DYNAMICS IN THE U.S.*

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Abstract

This paper uses the new Longitudinal Establishment and Enterprise Microdata (LEEM) at CES to investigate gross and net job flows for the U. S. economy. Much of the previous work on U.S. job flows has been based on analysis of the Longitudinal Research Database (LRD), which is limited to establishments in the manufacturing sector. The LEEM is the first high-quality, nationwide, comprehensive database for both manufacturing and non-manufacturing that is suitable for measuring annual job flows.

We utilize the LEEM data to measure recent gross and net job flows for the entire U. S. economy. We then examine the relationships between firm size, establishment size, and establishment age, and investigate differences resulting from use of two alternative methods for classification of job flows by size of firm and establishment. Cell-based regression analysis is used to help distinguish among the effects of age, firm size, and establishment size on gross and net job flows in existing establishments.

We find that gross job flow rates decline with age, and with increasing establishment size when controlling for age differences, whether initial size or mean size classification is utilized. Firm size differences contribute little or nothing additional when establishment size and age are controlled for. However, the relationship of net job growth to business size is very sensitive to the size classification method, even when data and all other methodology are identical. When *mean* size classification is used, the coefficient on establishment size for net job growth is generally positive, but when *initial* size is used, this coefficient is negative. These results shed light on some of the apparently conflicting findings in the literature on the relationship between net growth and the size of businesses.

Key Words: Longitudinal establishment microdata, gross job creation and job destruction, net employment growth, business size classification.

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1. Introduction

Over the past decade, techniques for measurement and economic analysis of job creation and job destruction have evolved significantly. An extensive literature documents the high rates of gross job flows, the heterogeneity of job creation and job destruction across plants, the quantification of job reallocation and worker reallocation, and the evaluation of heterogeneity in plant-level employment dynamics. Most of the early work on this topic was based on Dun & Bradstreet data.[1] Studies of employment in certain states made use of administrative data from the Unemployment Insurance system.[2] Much of the more recent analysis has focused on the Longitudinal Research Database (LRD) housed at the Center for Economic Studies at the U.S. Bureau of the Census.[3]

There are three broad limitations of these job flows analyses based on the LRD. First, the LRD is limited to establishments in the manufacturing sector of the U. S. economy, which represents less than 20 percent of the private sector jobs in the U.S. Second, the LRD's ability to measure firm size is very limited, because comprehensive measures of even just the total number of manufacturing jobs in firms exist only in Economic Census years, which take place every five years. This has not been sufficient for much analysis of firm size differences in job flows. Third, very small firms are not measured or are measured inconsistently in the LRD.

We exploit the new Longitudinal Establishment and Enterprise Microdata (LEEM) file, a tremendously rich economy-wide longitudinal database with universal coverage that overcomes these

[1] Birch, 1979, Armington and Odle, 1982, Brown and Phillips, 1989, Eberts and Montgomery, 1995.

[2] Anderson and Meyer, 1994; Lane, Stevens and Burgess, 1996; and Spletzer, 1998.

[3] Davis and Haltiwanger, 1990, 1992; Davis, Haltiwanger and Schuh (DHS), 1996a and 1996b; and Dunne, Roberts and Samuelson, 1989a and 1989b.

limitations. This is the first nationwide high-quality longitudinal database for both manufacturing and non-manufacturing businesses that is suitable for measuring gross job flows in this country. These data are also housed at the Center for Economic Studies at the U.S. Bureau of the Census.

The LEEM has several key advantages over the LRD. Of fundamental importance is its ability to track all individual establishments across changes in ownership or legal form, so that their continuing business activities can be more accurately followed over an extended period of time. Moreover, the LEEM also identifies the parent firm of each establishment in each year, and provides its firm-wide employment, so establishments can be classified by the size of their firm. Finally, since the scope of the LEEM includes nearly all establishments with employees, there is complete coverage of even the smallest businesses, those with one to four employees- which make up about 60 percent of all U.S. employer firms. Relative to the LRD, the LEEM is restricted in frequency (it includes no quarterly data), and in historical time span (it is currently available only from 1989).

This article presents, for the first time, (1) gross and net job flow rates for the entire U. S. economy, (2) investigates the relationships between age, establishment size and firm size to job flows, and (3) examines the impact of alternative measures of business size on these measurements. Annual rates for establishment job flows for each industry division are presented in order to see how typical manufacturing is of the other sectors in the economy. Then differences in gross and net job flows by *age, establishment size* and *firm size* are examined for the whole economy. A comparison of annual rates of job generation classified by alternative measures of firm size and establishment size and age for manufacturing, services, and retail trade is also performed. We confirm prior findings about patterns of job generation which were based on data for either single states or single industries as representative of the whole economy.

Cell-based regression analysis is used to distinguish among the effects of age, establishment size, and firm size on the patterns of job creation, job destruction, job reallocation and net growth. Both firm size and establishment size were included (in addition to age) as independent variables in the regressions for establishments that are parts of multi-location firms. These regressions verify that gross job flows decline substantially with increasing age, even after controlling for size. The estimated coefficients for firm size are small, but positive, for all of the gross job flows. This indicates that for multi-unit firms, the negative effects of larger establishment size tend to be partially offset by the positive effect, of larger firm size. For single unit firms, the estimated coefficient on size is negative and statistically significant, after controlling for age. However, for multi-unit firms, the estimated coefficient on firm size has little relationship to net growth rates, after the size and age of the establishment have been taken into account. Where firm size is equivalent to establishment size (for single unit firms), firm size significantly affects net growth rates. These results appear to support recent empirical research on Gibrat's Law (Sutton 1997).

Since Davis, Haltiwanger and Schuh (1996a), and others, expressed concern that the apparent association of higher job growth rates with smaller businesses might be primarily due to a statistical fallacy, many researchers have been using mean size, rather than initial size, to classify businesses for analysis of differences in job flows by size. This practice of classification by mean size has been advocated to control for regression-to-the-mean-bias in analysis of job generation rates. However, this method itself has been controversial, and clearly introduces other statistical problems.[4] In order to measure the impact of these alternative methods, we use both the traditional initial size and the recently popular mean size methods of classifying businesses in analyzing size differences.

[4] Konings, 1995a; Baldwin and Picot, 1995; Carree and Klomp, 1996; Kirchhoff and Greene, 1997; Picot and Dupuy, 1998, Davidson, Lindmark, Olofsson, 1998.

We find that establishment size is negatively related to *gross* job flows, whether initial size or mean size is utilized. However, for *net* job growth, the coefficient on establishment size is generally positive when the *mean* size is used, but negative when *initial* size is used. Thus, it appears that net job growth rates of existing establishments tend to fall with increasing initial establishment employment, but rise with increasing mean establishment size, after controlling for age.

The rest of this paper is organized as follows. Section II discusses the database and some of the methodological issues. Section III presents some basic facts about job creation and job destruction based on the LEEM. Section IV summarizes results for the cell-based regressions on job creation, destruction, net change, and reallocation, distinguishing the separate effects of age, establishment size, and firm size on these rates. The final section concludes with a brief summary and a discussion of remaining challenges in measurement and basic analysis of job flows.

II. Data and Measurement

A. The Longitudinal Enterprise and Establishment Database (LEEM)

The Longitudinal Establishment and Enterprise Microdata (LEEM) file has multiple years of data for each U.S. private sector (non-farm) business with employees. The current LEEM file facilitates tracking employment, payroll, and firm affiliation and (employment) size for the over nine million establishments that existed at some time during 1990, 1994, or 1995.[5] This file was constructed by the Bureau of the Census from its Statistics of U.S. Business (SUSB) files, which were developed under

[5] The original LEEM file for 1990, 1994 and 1995 includes up to three years of data. Each year of data includes up to two Census identification numbers, establishment employment during the March 12 pay period, annual payroll, Standard Industrial Classification code (4-digit SIC), Metropolitan Statistical Area (MSA), state, and enterprise (firm) employment. This has been supplemented to include county for each of the three years, and the year of the establishment's first appearance in Census data (or 1973, if dated earlier).

contract to the Office of Advocacy of the U.S. Small Business Administration.[6] These data are an extended form of the economic microdata underlying Census' County Business Patterns. The annual SUSB data were linked together using the Longitudinal Pointer File associated with the SUSB in order to facilitate tracking establishments over time, even when they change identification numbers.

The basic unit of the LEEM data is a business establishment (location or plant). An establishment is a single physical location where business is conducted or where services or industrial operations are performed. The microdata describe each establishment for each year of its existence in terms of its employment, annual payroll, location (state, county, and metropolitan area), primary industry, and start year. Additional data for each establishment identify the firm (or enterprise) to which the establishment belongs, and the total employment of that firm.

A firm (or enterprise or company) is the largest aggregation of business legal entities under common ownership or control. Establishments are owned by legal entities, which are typically corporations, partnerships, or sole proprietorships. Most firms are composed of only a single legal entity that operates a single establishment -- their establishment data and firm data are identical. Only 4 percent of firms have more than one establishment, and they and their establishments are both described as multi-location or multi-unit. Multi-unit firms may be composed of one or more legal entities.

The overall size of a firm indicates the scale of financial resources and decision-making overseeing of operations. This corresponds closely to the notion of business size that underlies most public discourse on job creation. In addition, patterns of government regulation and business access to

[6] For documentation of the SUSB files, see Armington, 1998, which is available from the Office of Advocacy of the U.S. SBA.

financial markets are more closely associated with firm size than with the size of plants or branch locations (Armington, 1982).

Looking at the employer establishments, about 77 percent are single unit establishments, with an average employment of about eight. The other 23 percent belong to multi-unit firms, and these establishments have an average of 39 employees. However, there are a few very large single unit firms, and many very small multi-unit establishments.

Establishments that continue their operations can usually be tracked through time using the LEEM, even if their identification numbers are changed due to structural, legal, or ownership changes in the business. Therefore, it is generally possible to clearly identify the startup (birth) of a new establishment or the termination (death or closure) of an establishment, as distinguished from the appearance of a new identification number or the discontinuance of an old one. In fact, we normally impose the additional requirement that a new establishment have positive employment before recognizing it as an establishment birth. Further, we assume that when an establishment that did have employment loses all of its employees, it constitutes an effective closure, even if it again reports employees in later years.[7]

B. Gross job creation, destruction and reallocation and net job change

We now turn to issues of measurement. The most appropriate way to measure differences in job creation and job destruction by different sizes of firms or establishments has been a controversial issue for more than two decades. Ever since Birch (1979) first released his initial findings on

[7] For a more complete description of the Census' SUSB source data and the characteristics of the LEEM data see Acs and Armington (1998).

employment dynamics, debates over his results have continued, in part because he has never released details on his methods of measurement. [8]

According to DHS (1996a, 66), "Most longitudinal studies of the relationship between employer size and job creation suffer, from another statistical pitfall known as the regression fallacy or regression-to-the-mean bias."[9] The regression fallacy is a problem well known to most researchers, but not always avoided by them. The essence of the regression fallacy is that when repeated measures are made for members of extreme categories on a scale, measurement error or random fluctuations over time tend to result in changes primarily in only one direction from each extreme -- towards the mean. In analyses of longitudinal data on job creation by size class, this fallacy might result in overstatement of the job creation by smaller businesses, and overstatement of the job destruction by larger businesses

There are two solutions to the controversy about the regression fallacy. First, to measure the size of the fallacy and determine how serious it is, and second, to develop alternative methods to avoid the fallacy, without introducing new distortions. In order to better assess and/or avoid the regression fallacy, one needs to understand the phenomenon being measured. If we view the size of establishments or firms as fixed in the long run, then most job generation is due to fluctuations around that long run size. However, there are good reasons to believe that this is not generally the case. First, businesses are continually confronted with changes in their economic environment, which are likely to result in changes to their optimum size. Such changes conflict with the theory of an optimal long run business size with minor, symmetrical, fluctuations around it. Second, the long run size of young businesses cannot be

[8] For a review of the literature on industrial organization and job flows see (Caves, 1998).

[9] Friedman (1992) suggests that the regression fallacy "is the most common fallacy in the statistical analysis of economic data."

identified until they are mature. In fact, DHS (1996a) found that only larger and older multi-unit plants exhibited pronounced counter-cyclical patterns of variation, i.e. temporary changes in employment. They found little or no systematic relationship between the business cycle and job generation in young, small or single unit plants.

An alternative view of firm or establishment size suggests that businesses enter an industry, survive, grow and decline over time (Audretsch, 1995). This evolutionary view suggests that the size of an establishment is unlikely to fluctuate around a long run equilibrium size. In this view, businesses generally show a *persistent* growth or decline in jobs, while in the above case they tend to show *temporary* changes in their levels of employment.

These two schools of thought concerning firm growth and firm size need further examination. Adherents of the first school support the assumption that firms fluctuate around their own size, and deviations from this are temporary (Leonard, 1986). The analysis in Leonard starts with equation (1):

$$\ln S_{it} = X_i \beta + \varepsilon_{i,e} \qquad (1)$$

where S_{it} is the size of firm i in period t, X_i is the vector of firm characteristics given optimal scale, i. e., a vector of time invariant characteristics, and $\varepsilon_{i,e}$ is a random error that may include measurement error. The expected growth, conditional on initial size ($\ln S_{i,t-1}$) equals $-\varepsilon_{i,t-1}$. Thus, compared to their expected size, large firms are expected to shrink and small firms are expected to grow. Adherents to this school assume that firm size fluctuates randomly around the expected value of $X_i \beta$ in equation (1).

Followers of the second school analyze whether the firm growth rates fluctuate randomly, i.e., whether Gibrat's law is valid. In Evans (1987b) the following regression framework is presented:

$$(\ln S_{i,t} - \ln S_{i,t-d})/d = \ln G(A_{i,t-d}, S_{i,t-d}) + \eta_{i,t} \qquad (2)$$

where d is the number of years between the beginning and the end of the observation period, A is firm age, and $\eta_{i,t}$ is a random error. Variyam and Kraybill (1992) and Mata (1994), for example, also use this approach.

Moreover, there is some empirical evidence to doubt that equation (1) describes the dynamics of firm size. Evans (1987a and 1987b) and Hall (1987) report finding that firm growth decreases with firm age and with firm size. Beori and Cramer (1992) show for German establishments in the period 1977-1990 that the growth-size relation is not the result of a regression-to-the-mean bias only. Konings (1995a and 1995b), using a similar technique, found no evidence of convergence, and hence no measurable regression-to-the-mean. [10] Dunne, Roberts, and Samuelson (1989) separated establishments in single unit firms from establishments in multi-unit firms and found that the former experienced a decline in net growth with size across age groups, while the latter experienced a U-shaped relationship in young plants and a positive relationship in plants over five years old.

However, Davis and Haltiwanger (1998) found that, after controlling for age, net growth in manufacturing increased with mean plant size. Results from Nocke (1994), using French data, displayed similar patterns for net growth for the smaller size categories, but French growth rates leveled off for the larger plant sizes. These results contrast with findings by Evans (1987b) and Hall (1987), who both found that net growth rates declined with firm size, even after controlling for firm age. Davis and Haltiwanger (1998, 17) suggest these conflicting results arise from regression-to-the-mean effects,

[10] Using Swedish data, Davidsson, Lindmark and Olofsson (1998) actually estimate the size of the regression-to-the-mean-bias. They conclude that, "In all, correcting for the "regression-to-the-mean bias" in these data amounted to correcting for fractions of percentages. Our conclusion would be that in analyses similar to ours…the regression fallacy highlighted by DHS (1996a, 1996b) leads to relatively insignificant distortions and has not led researchers to draw qualitatively false conclusions from such analysis" (p.97).

due to the fact that Evans and Hall used the employment size in the initial year for calculating net growth and for classifying sizes. Other differences in techniques and time frame also play a role in producing these diverse results

Another source of possible bias in analysis of job flow differences by business size is the use of traditional growth rate calculations based on initial period employment. These rates are both asymmetrical and unbounded, so large positive changes in small establishments result in extremely high rates, while similarly large negative changes are limited to a loss rate of 100 percent. To avoid this bias, we have adopted the method of calculating rates of change in employment used by DHS (1996a, 26). They measure a plant's growth rate in period t as the change in its employment divided by its average employment in periods t-1 and t. With this unconventional measure, rates of job creation and job destruction will be symmetrical -- an increase of x jobs, followed by a decrease of x jobs will translate into the same rate with opposite signs.[11] Unlike the conventional growth rate measure, which divides employment change by initial year employment and ranges from -1.0 to + ∞, this mean-based growth rate measure ranges from –2.0 for establishment closures to +2.0 for establishment startups. This method of calculating growth rates removes a source of bias, but does not, in fact, affect most results noticeably.

Following DHS (1996a), we define changes in establishment employment using three subscripts. The letter *e* denotes a specific establishment; the letter *s* denotes the sector to which the establishment belongs; and the letter *t* denotes the time period. The symbol Δ denotes the first-difference operator, such as $\Delta X_t = X_t - X_{t-1}$.

Gross job creation is the sum of all new jobs at an expanding or newly born establishment. Formally, gross job creation in sector s at time t is:

$$C_{st} = \sum_{e \in s+} \Delta X_{est}, \quad \textbf{(3)}$$

And gross job destruction is

$$D_{st} = \sum_{e \in s-} |\Delta X_{est}| \quad (4)$$

where X denotes employment, and the subscripts + and – indicates the subset of establishments in the sector that expand and contract respectively. We define job creation rates by dividing by a measure of size, mean employment. Mean establishment employment, Z_{est}, is the average of employment in period t-1 and t:

$$Z_{est} = 0.5(X_{est} + X_{es,t-1}), \quad (5)$$

and the corresponding establishment growth rate is:

$$g_{est} = \Delta X_{est} / Z_{est}. \quad (6)$$

This is a convenient approximation to the continuous, or compounded, growth rate. The continuous growth rate is calculated as $\ln X_{est} - \ln X_{est-1.}$ Sectoral rates of gross job creation and destruction are employment-weighted sums of establishment level growth rates:

$$c_{st} = C_{st}/Z_{st}$$

and

$$d_{st} = D_{st}/Z_{st.}$$

[11] Thus, for example, an expansion from 100 to 110 is equal in size and opposite in sign to a contraction from 110 to 100.

The sum of job creation and destruction is defined as the reallocation rate between t-1 and t:

$$r_{st} = c_{st} + d_{st}.$$

Gross job creation and destruction are related to the net change in employment, or net job creation, by the following formula:

$$Net_{st} = c_{st} - d_{st} = (\Delta X_{st}/Z_{st}). \qquad (7)$$

We measure establishment employment flows using both initial size classification and mean size classification. For job flows over the period from t-1 to t, the initial year method classifies all establishments and/or firms according to the size of the establishment and /or firm in the initial year, t-1. New establishments are also classified by their initial size, which is that reported in year t, the ending year of the interval. New establishments in firms that did not exist in the initial period also use their firm size in the ending year as their initial firm size.

The mean size classification method is a special case of a longer-term weighted average size approach. It uses a weight of one half for initial year and one half of ending year. Thus, for mean firm size firms are classified strictly according to the average of the firm size in the initial and ending year class, using zero when the firm did not exist. Mean establishment size is calculated similarly.[12]

In order to examine the differences in growth rate patterns associated with the different size classification methods we looked at growth classified by establishment size for establishments in each of six age groups. In Figure 1, the upper panel shows the patterns using initial size of each establishment for classification, while the lower panel uses mean establishment size. These plots generally show the

[12] For definition of cells for cell-based regressions, a modified mean size method was utilized. Solely for the purpose of appropriately classifying mean size at death, initial size was used as the modified mean size, rather than half of the initial size (which results from averaging in the zero employment after death).

growth patterns for most of the age cohorts closely clustered, but the pattern for one-year-old businesses is quite distinct from the older ones.

Looking first at the patterns in Figure 1 when we classify establishments according to their initial (1994) size, net employment growth clearly declined with increasing establishment size, after controlling for age. The youngest establishments decline more sharply while the older ones spread out more. When we classify establishments according to their mean (1994) size we find that, after controlling for age, net job growth rates increase with mean establishment size across the smaller size classes, but then level off. Again the youngest establishments have higher average growth rates then older establishments across all but the smallest size class. While not shown, these results also hold in each of the three industry sectors—manufacturing, retail, and services—as well as single unit firms and establishments in multi-unit firms. [13] These results are striking since both classifications are based on the same 3.6 percent annual growth rate.

While much of our analysis is based on the annual change in establishment employment between March 1994 and March 1995, we frequently reference the five-year changes from 1990 to 1995 in order to verify that the patterns we find for a single year also persist over the longer period. It is important to understand why the five-year gross changes are not approximately five time the annual changes. The typical effect of the use of different frequencies (measurement intervals), is evident by imagining measuring job generation on a quarterly basis in an industry with a large annual seasonal

[13] It should be kept in mind that all of these analyses controlling for age must omit the growth due to establishment births, since births all have an age of zero (or one) and a growth rate of 200 percent. Therefore, the relationship being explored is that of net and gross job flows in the establishments that already existed in the initial year of each analysis.

component to employment variation, such as construction, or agricultural services. Such an industry would have large job creation rates in certain quarters, and corresponding large job destruction rates in other quarters, while its gross annual job flows (e.g. March to March) would be relatively small. Much of the job creation and destruction activity would be transitory within the year, so the annual gross changes would be far smaller than the sum of quarterly changes. Indeed, the ratio of the sum of quarterly gross job flows to the annual flows is a good measure of the extent to which flows are reversed within the annual period.

The shorter-term job generation that is reversed within a longer time interval is not limited to expansions and contractions of individual establishments. Much of it may be in the form of new business startups, which may then expand, but eventually contract and even close before the end-point of the measurement interval. As the length of the measurement interval increases, there will be more businesses that both start up and close during the gap between the measurement points, so they never appear in the beginning or ending point data. For example, assuming that businesses are born at a regular annual rate during the interval from 1990 to 1995, but are measured only in 1995, the births which appear at this end point are only the subset of each year's births which survived until the end-year measuring point.[14]

III. Basic Facts about Job Creation and Destruction in the 1990's

We begin our characterization of the facts by reviewing some prior findings about the magnitude of job flows[15]. While these studies differ in time period, sampling interval, sectoral coverage and

[14] See Armington (1995) for further details on the impact of frequency differences on job creation measures.

[15] Dunne et al, 1989 b; Baldwin et al, 1996; Anderson and Meyer, 1994; Leonard 1987; Foote, 1997; Davis and Haltiwanger, 1992 and 1998; Lane et al. 1996; and Spletzer, 1998.

definition of business unit, several clear patterns emerge from them. First, and most important, the pace of gross job creation and destruction is rapid – many times that of net change in employment. Using annual figures for the manufacturing sector, Haltiwanger and Davis (1998, 8) "estimate that 1 in 10 jobs are created and another 1 in 10 are destroyed each year." Second, the rates of job creation are generally somewhat lower in manufacturing than in non-manufacturing. Third, are substantial transitory components in the higher frequency job flows, especially the quarterly flows, so that higher frequency figures do not sum to the corresponding lower frequency ones, for the same period.

Do these summary conclusions from previous studies hold for recent job creation and job destruction for the U. S. economy as a whole? In this section we present a preliminary examination of this question using establishment and enterprise data from the LEEM for the periods 1990-1995 and 1994-1995.

A. Employment Flows by Industry Sectors

Some of the basic facts that emerge from our measurement efforts are striking. The large size of the gross job flows is evident in the upper panel of Table 1, which reports 1990 U.S. employment levels by industry sector, along with their rates of net change, and their gross job creation, job destruction, and job reallocation for the period from 1990 to 1995. The job reallocation (the sum of job creation and destruction) rate was 77.8 percent for the U. S. economy as a whole for the five-year period, but there was large variation by sector. The highest rates of job reallocation were in construction, mining, finance, and agricultural services (95 to 90 percent). This was followed by retail trade, wholesale trade, transportation et al., and services (83 to 77 percent). Manufacturing had, by far, the lowest job reallocation rate, at 59.7 percent.

We can compare these five-year gross flow figures with earlier work by Dunne et al. (1989) for the manufacturing sector reported at the establishment level. They reported average job generation rates for U. S. manufacturing from four five-year intervals for the period 1967-1982. Their average five-year job reallocation rates for manufacturing were 60.5 percent -- just one percentage point higher than the LEEM numbers for the 1990-1995 period. Gross job creation rates are also very similar, with 29.6 percent versus 28.2 percent from the LEEM and for destruction 30.9 percent versus the LEEM's 31.5 percent. These results are remarkably similar, given the different time periods and measurement methods.

The lower panel of Table 1 presents annual establishment employment flows by industry for March 1994 to March 1995. Employment increased by 3.6 percent in that interval. Annual job reallocation for the whole economy was 29.6 percent. This figure is higher than any reported previously for annual data for the U. S. economy. While it is close to the 27.1 percent figure reported by Leonard (1987) for the state of Wisconsin, it is 50 percent higher than the 19.6 percent rate reported by Foote (1997) for Michigan. These job creation and destruction rates indicate that 1 in 6 jobs was newly created during this year, and 1 in 7 jobs was destroyed

Across different sectors of the economy, annual job reallocation rates ranged from a high of 45.2 percent in construction to a low of 21.2 percent in manufacturing. The figure for manufacturing is just 1.8 percentage points higher than the 19.4 percent average annual rate reported by DHS (1996a, 39). Thus, our figure for gross job flows in manufacturing is again close to previous estimations. However, the LEEM data show gross job flows in the non-manufacturing sectors of the economy averaged 31.5 percent, almost half again higher than the manufacturing sector. Therefore, it is obvious that job flows in manufacturing are not typical of the aggregate economy (Spletzer, 1998).

These data in Table 1 confirm the first regularity of job generation -- that gross job flows are very large in comparison with net changes. However our findings contradict the second regularity -- that job flows are slightly larger in non-manufacturing than in manufacturing. We found job generation in manufacturing to be substantially lower than that in any other sector. The comparison of one-year changes with five-year changes in Table 1 also support the third generalization – that some of the annual changes were transitory, since the annual changes are far greater than a fifth of the five-year changes. Indeed, the five-year changes are generally only 2 to 2.5 times the annual change rates, suggesting that much of the change in numbers of jobs was not part of a continuing long-term pattern of growth or shrinkage by those establishments.

B. Employment Flows by Establishment Size Classification

Having established the general magnitude of gross flows in the economy, we now turn to the question of how these flows vary for different sizes of establishments, and the issue of how to measure establishment size for this analysis. For comparison purposes, employment flows classified by establishment size are shown using both initial and mean establishment size classifications in each table that shows size classifications. The top panel of Table 2 provides annual job generation rates for establishments classified by their employment in the initial year, which is 1994 generally, but 1995 for births.[16]

Several patterns are evident in these gross and net job flow rates in Table 2. First, net job creation is negatively related to the initial size of establishments, as are each of the gross flows—job

[16] Mean employment is always used in this paper for calculating job flow rates from the gross job changes, regardless of which employment measure is used for classification of size. Therefore the creation rates and destruction rates are

creation, job destruction, and reallocation. In other words, as establishment size increases, both the net job creation rate and all gross flow rates decline sharply. Only the largest size class breaks this pattern, with somewhat higher net growth, destruction, and reallocation. Second, very small establishments create jobs at much higher gross rates than larger establishments, leading to a very high net growth rate for these tiny establishments.

The lower panel of Table 2 reports the same job flows for establishments, but here the size of establishments is classified according to their mean employment in 1994 and 1995, regardless of whether they existed (had any employees) in both periods. The growth rate patterns here are similar to those in the top panel, with all gross flow rates decreasing as mean establishment size increases. The net change also decreases, but it has a few higher rates among the middle size classes.

Comparing the top and bottom panels in Table 2 more closely, we see that the use of mean establishment size classification greatly reduced the job creation included in the smallest firm size class (1-4). Its net job growth rate fell from 18.2 percent to 4.4 percent when we shifted from initial to mean size classification. This is due to both a decrease in job creation (as the larger expansions are shifted to higher classes) and an increase in job destruction by the smallest firm size class (increasing from 17.9 percent to 29.0 percent as contractions from larger size classes shift to the smaller class).

Throughout the size distribution, the use of the mean establishment size classification tends to shift contracting establishments' job destruction to the smaller establishment size classes. Similarly, much of the expansion in jobs by establishments that were small in 1994 is shifted to larger establishments. When initially small establishments grow rapidly, all of their growth is attributed to larger

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symmetrical, and the range of possible growth rates is bounded by the rates for births and deaths, which are 200 percent and –200 percent, respectively.

establishment mean size classes. Notice that both net and gross job creation rates distributed by mean size classes are larger than the corresponding one using initial size for all classes of establishments with more than 19 employees, except the open-ended class with at least 5,000 employees

C. Employment Flows by Firm Size Classification

In their extensive study of job creation and destruction in manufacturing, DHS (1996) found a strong negative relationship between the long-run average firm size and job reallocation rates (*gross* turnover). The recent data from the LEEM affirm this relationship for manufacturing establishments, as shown in the consistently descending line for manufacturing in Figure 2. The construction sector and the transportation, communication, and public utility (TCPU) sector also exhibit a declining slope, although not as strong. However, for all other large industry sectors shown in Figure 2, the negative relationship of reallocation rates to firm size holds only for establishments in smaller firms.

Table 3 presents employment flows for establishments classified by the size of their firms – the aggregate national employment of all establishments belonging to the firm. About 77 percent of establishments are single location firms, so their firm size and establishment size are identical, and their classification is the same in Tables 2 and 3. The other 23 percent of establishments (with over 50 percent of employment) belong to multi-unit firms, and their firm size is generally larger than that of each component establishment. Comparing the 1994 employment in the initial size class for firms with 1 to 4 employees in Table 3, to that for establishments with 1 to 4 employees in Table 2, it is apparent that about 800,000 (or 13%) of the employees in those tiny establishments actually worked for larger firms. The corresponding decrease of about 5.4 million employees (or 28%) in the 5 to 19 firm size class has a more complex explanation. It is the net effect of the addition of some of those 800,000 jobs that were reclassified from the smallest establishment size to a larger firm size, and the subtraction of more than

5.4 million jobs in establishments with 5 to 19 employees that belong to firms with more than 19 employees. Many of the larger firms own or control many of the smaller establishments.

At first glance, the Table 3 patterns of job generation rates decreasing with increasing firm size look quite similar to those of Table 2, which is classified by establishment size. On closer examination however, it is apparent that the negative relationship between firm size and job flows is weaker for the larger size classes, which contain primarily multi-location firms. Each of the flows measured – net change, and gross job creation, job destruction, and reallocation -- appears to have a consistent monotonic, negative relationship with *initial* firm size only for firms with less than 1000 jobs.

The relationships between job generation rates and *mean* firm size are somewhat weaker than the corresponding ones with *initial* firm size. When classifying by initial firm size, net average employment growth ranged from 17.7 percent to 1.4 percent as firm size increased. This trend is still evident using a mean firm size classification, although less consistent, with net growth falling from 5.2 percent to 1.8 percent. Omitting the smallest size-class, which is strongly influenced by births of small new firms, the remaining pattern of net growth rates by mean firm size is mildly "n"-shaped. [17]

[17] DHS (1996a) found no strong pattern between *net* job creation and firm size for U. S. manufacturing , although they did observe a negative relationship between long-run average firm size and job reallocation rates. We directly compare annual net job creation rates by mean firm size for the entire nonfarm sector with the corresponding LRD data from DHS (1996a, Table 4.1, p. 61). The older manufacturing data from DHS exhibit a weakly n-shaped relationship between firm size and net job creation, with the 100-499 size class at the peak. The more current LEEM annual data for all industries show a similar pattern, but with the 500-999 firm size class at the peak. However, the downward trend in the size-classes with over 1,000 employees is much more pronounced for the LEEM all-industry data. Using a five-year interval the n-shaped pattern is much more pronounced, with a strong positive relationship between net job creation and firm size for establishments in firms with less than 500 employees, and a strong negative relationship between net job creation and firm size for larger firms.

Comparison of 1994 to 1995 job growth patterns by firm-size for major sectors exhibit somewhat diverse tendencies. In manufacturing establishments, net growth was inversely related to both the initial firm size and the mean firm size. In the service sector, the negative relationship of net growth to firm size held only for firms with initial size under 1,000 employees, or mean size under 500 employees. For larger firms, no systematic relationship could be detected. The retail trade sector's growth was inversely related to firm size only in the smaller (less than 100 employees) firm sizes, both for initial and for mean size classification.

D. **Job Flow Differences by Establishment Age**

Net and gross job flows by age[18] of establishment are reported in the top panel of Table 4 for all establishments that existed in 1994 or 1995, and in the bottom panel for all non-birth establishments in 1994 that survived to 1995. Note first that the net growth rate for establishments that started in 1995 was, by definition, 200 percent, and included only job creation. While establishments that started in 1994 did have a substantial rate of job loss, they still netted job growth of 64 percent. All older businesses lost more jobs than they gained during the year from 1994 to 1995. Thus, while the net job growth rate clearly declines with establishment age, this decline appears to be concentrated in the first three years of the life of establishments.

[18] The age of an establishment on the LEEM is determined from the year in which it first appears in the Census data system (Acs and Armington, 1998). When establishment records with different Census identification numbers are linked together to represent a continuing establishment, the start year of the oldest is used. However, establishment births (for 1994-1995, for instance) are identified as all establishments reporting employees in 1995 that had no employment in March of 1994. These are all assigned a start year of 1995 for the purpose of analysis of 1994 to 1995 changes. Because we base our growth rate measures on mean employment, rather than initial employment, so that expansion and contraction will be symmetrical, all establishment births have a growth rate of +200 percent. The job creation rate and net growth rates for the birth year (1995 in the example above) will therefore always be 200 percent.

Gross job creation rates declined strongly with establishment age, across the entire range of ages measured. For the whole economy in 1994 to 1995, gross job creation in existing establishments declined from 80.3 percent to 7.9 percent as age increased. Gross job destruction rates also declined with age, but less strongly, and beginning only from age two. Job loss rates for one-year-old establishments were about the same as for six-year-olds.

Employment volatility also declined fairly strongly with establishment age, as indicated by the figures for job reallocation. For establishments that were one year old (started in 1994), the annual job reallocation rate was a remarkable 96.6 percent. It dropped to 36.7 percent by the time establishments were three years old, and then gradually declined to 17.1 percent for plants that started in or before 1977.

What mechanism might account for such a systematic negative relationship between job reallocation (or lack of employment stability) and establishment age? Jovanovic (1982) and Ericson and Pakes (1995) suggest an explanation based on the selection effects associated with learning about a new establishment's prospects for profitability. At the time of an establishment's entry, the business (often a single-location firm itself) faces uncertainty regarding its prospects for profitability and market share. After entry, the management accumulates experience and information. An establishment that accumulates favorable information about its profitability survives, and may expand to some optimum size, which it then tries to maintain with only transitory small changes. Those that accumulate unfavorable information exit as soon as they recognize their status, to minimize their losses. Apparently, in most cases, it takes more than a year to make this decision, so that destruction rates peak in the second year after startup.

Other evidence to support this explanation is set out by Nucci (1999), who documents how business survival rates rise rapidly as age increases. Many of the new businesses learn rapidly about their poor prospects for success, and close in their first year, so they never appear in the LEEM (if they never had positive payroll in the first calendar quarter). Many that survive to their second year have already accumulated substantial favorable information, but a fraction of the remainder in that year, and in each succeeding year, decide against continuing, and close. This pattern of substantial, but decreasing, job destruction from closures in the first few years after startup, combined with the substantial job creation associated with business births, accounts for much of the strongly higher reallocation rates in the younger businesses.

IV. Separating the Effects of Age, Firm Size, and Establishment Size

In this section, regression analysis is used to help distinguish among the effects of age, firm size, and establishment size on the patterns of job creation, job destruction[19], net job growth, and job reallocation in U.S. establishments. In each of the tables above we have examined the various job flow rates while controlling for one of these factors at a time (sometimes further limited to a single industry sector). Some of the figures allow us to examine the patterns when controlling for two factors at a time, but these have not led to clear conclusions. All of these factors are intercorrelated, so that the regression analysis will not produce unbiased measures, but it will provide useful rough estimates of the separate impacts of these factors on average rates of gross and net employment change.

[19] We calculate job destruction as a positive number. For example if a firm had 20 employees in 1994 and 15 in 1995, job destruction would be 5. Likewise, if an establishment had 20 employees in 1994 and 25 employees in 1995, job creation would be 5. Thus, Net = creation - destruction and
Reallocation = creation + destruction.

An important underlying question is the relative importance of the size of establishments (locations or plants) versus the size of firms (enterprises or controlling legal entities) in explaining differences in average job flow rates. [20] Decisions about levels of employment in single-establishment firms are clearly made by the management of that establishment/firm. Establishments that are parts of multi-establishment firms vary in their levels of decision-making autonomy, and we have no basis for classifying their relative independence.[21] However, because nearly 80 percent of private sector establishments are single-establishment firms, and large multi-unit establishments are always in large firms, firm size and establishment size are highly correlated. Therefore, previous analyses have generally shown similar results, whether based on firm size or establishment size. Indeed, because of limitations on data, much analysis in the past has interchanged the two measures -- using firm size measures to test theories about plant size, or using establishment size as a proxy for firm size. The LEEM provides accurate data on both firm size and establishments size, so that we can test the relative strength of their respective impacts on job growth.

Business births are the class of establishments with age of zero (or starting year equal to the ending year of the growth analysis), and the symmetrical growth rate calculation we are using (based on mean employment) sets their growth rate to a constant value of 200 percent for births. Therefore we cannot include births in this analysis of the joint effects of age and other variables on job flow rates without seriously biasing the estimates. Establishment deaths, on the other hand, are distributed over all age classes, and can therefore be treated as contractions to zero employment. The job flows analyzed

[20] Firm size is summed across industries.

in this section thus include only those of pre-existing businesses, excluding the substantial job creation from births of new establishments (both new single establishment firms and new branches of existing firms). Because deaths are included and births are excluded, the net growth rates used in this analysis are generally negative, even when employment was growing.[22]

A. Measurement of variables

Since our goal in this regression analysis is to separate the effects of the various factors discussed above on the average gross and net job flow rates observed for groups of similar establishments, cell-based regressions were used. The observations on individual establishments were grouped into cells with other establishments that had similar characteristics. Then average gross and net job flows were calculated for each cell, based on the aggregate changes of all the establishments in each cell. These constructed cells then became the observations on which the regression analysis was based. Since the cells varied greatly in the aggregate amount of employment they represented, the regressions were weighted by the sum of the employment[23] of all establishments in each cell.[24]

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[21] Armington (1982, 14) argued that it is the parent firm that makes the business policy decisions that determine much of the behavior of the establishments that it controls, so the size of the parent firm should be the better indicator of expected job growth rates.

[22] During the period from 1994 to 1995,the creation rate was 16.6 percent. Births contributed 5.8 percent to the creation rate, while expansions averaged job creation of 10.8 percent. Including births, the net job change rate for that period was 3.6 percent. However, this falls to -2.2 percent when births are excluded. For the five-year period from 1990 to 1995, births contributed 25.9 percent to the net job creation rate of 7.1 percent, so the existing establishments alone had a net job creation rate of -18.8 percent.

[23] The sum of mean employment (averaging in zeros for deaths) was used to weight the regressions based on mean size classifications, and the sum of initial employment was used to weight the regressions based on initial size classifications.

[24] Alternative regressions were run using the number of establishments in each cell as weights, and the results were very similar for single-establishment firms, and somewhat stronger for multi-unit establishments. This is probably

Gross job creation, destruction, and reallocation rates, and net job change rates in each cell are calculated by dividing the sum of each flow by the sum of mean (of initial year and ending year, including zeros for deaths) employment for all establishments in the cell. Under this specification, the rates are constrained to be less than 200 percent (because births are not covered) and greater or equal to –200 percent.

Each establishment with positive employment in the initial year (1994 or 1990) is assigned to a cell which is defined by a relatively narrow range of values for age, establishment size, type of firm (single or multi-unit), industry sector, and firm size[25]. These cells are bounded as follows:

- age classes:

for the 1994-1995 growth analysis, 2 years (start year = 1994), 3, 4, 5, 6,

7-8, 9-13, 14-18, and 19 or more years.

for the 1990-1995 growth analysis, 1 year (start year = 1990), 2, 3, 4, 5, 6,

7-8, 9-10, 11-13, and 14 or more years.

- establishment-employment size-classes:

1-4, 5-19, 20-49, 50-99, 100-499, 500-999, 1000-4,999, 5,000 or more

- type of firm:

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due to the lower weighting of the frequently eccentric behavior of a small number of relatively large establishments in multi-unit firms. Although this weighting by observations probably produces better estimates of the separate effects of our exogenous variables on job flows of establishments, the results of the employment-weighted regressions are shown instead, since the preceding tables and figures, which we are attempting to clarify, are inherently employment-weighted.

[25] Several other specification were explored to measure the additional impact of firm size (beyond that of establishments size) on job flows, but they were generally not significant. These included the ratio of firm size to establishment-size, and the residual firm employment in other establishments belonging to the firm.

single establishment or multi-establishment

- firm-employment size-classes:

  1-4, 5-19, 20-49, 50-99, 100-499, 500-999, 1000-4,999, 5,000-9,999, 10,000-24,999, 25,000 or more

- industry sectors (divisions):

	SIC
Agricultural services	07-08
Mining	10-14
Construction	15-17
Manufacturing	20-39
Transportation, communications, and public utilities	40-49
Wholesale trade	50-51
Retail trade	52-59
Finance, insurance, and real estate	60-69
Services	70-89
Unclassified.	99

Although they are derived from cell averages that are bounded by the cell definitions, age, establishment-size, and firm size were treated as continuous variables. Since the age classes were quite limited, the mid-point of each closed age interval, as an approximation to the median, was used as the value for each cell. For each of the two open age ranges, a median value was estimated to represent

the central point of their age distribution.[26] Since the effects of age differences on job generation appear to be much stronger for the first several years, and fall off rapidly after several years, the natural logarithm of age was used to transform the effects to approximate linearity.[27]

The establishment employment for each cell was calculated as the average initial or mean employment of all establishments in that cell, and for cells with multi-unit establishments, the average firm employment was similarly calculated from the initial or mean employment of their owning firms. These business size variables were also expressed as natural logarithms, as their expected impact was not proportional to their levels, but to percentage differences in their levels.

Four sets of cell-level data were constructed, each set representing the complete universe of private sector employer establishments that existed at the beginning of each measurement period. Two of the sets measured the annual job flows over the period from 1994 to 1995, and the other pair covered the five-year job flows from 1990 to 1995. For each of these periods, one set of data was tabulated on the basis of classification by mean[28] employment (both firm and establishment employment) and the other by initial employment of establishments and firms. The corresponding employment concepts were used for calculating the average values to represent each cell for the alternative bases.

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[26] For the 1994-1995 job generation analysis, the cells with establishments which started in 1977 or earlier (aged 19 or older) were assigned a median age of 21 years. For the 1990-1995 job generation analysis, the cells with establishments that started in 1977 or earlier (aged 14 or older) were assigned a median age of 17 years.

[27] This assumption of linearity with the logarithm of age was tested, and the results are discussed below in the section on age.

[28] When determining mean employment for cell classification for this regression analysis, zero values are not used. Thus, establishment deaths are classified by their last positive observed size (rather than half their size, as the strict mean would dictate). If the firm also disappears then its last observed positive size is also taken to represent its mean size. Both are probably understatements of the longer run sizes.

For each of the size classification methods (initial size and mean size) regressions were run separately on the three major industries (manufacturing, retail, and services), as well as the aggregate economy, for the two time periods and the two types of firms (single and multi-unit). The numbers of cells for each regression vary from 54 to 3,788, with the higher numbers for multi-unit establishments, because they have an additional dimension.[29]

B. Regression model

Multivariate regressions assist us in distinguishing the contribution to gross and net job flow averages from each of the factors previously discussed. Here it is assumed that each of the four flows mentioned above – gross job creation, destruction, and reallocation, and net job change – varies as a function of the age of the establishment, the size of the establishment, and additionally, by the firm size if it is in a multi-unit firm. These relationships are estimated separately for establishments that are single unit firms, and for those that belong to multi-unit firms.

The relative sizes of these flows are likely to vary as a function of the relative values of the explanatory variables, not as a function of differences in their levels. A difference of 2 years in age should have a greater impact when it is between 1 and 3 years than when it is between 8 and 10 years. Similarly, a difference of 50 employees should have more impact when it is 50 percent of employment

[29] Those run on the aggregate economy used cells defined by the nine industry divisions, so they generally had 9 times as many cells as the individual industry regressions. Those for a single industry run on single-unit establishments did not use a firm size dimension in their cell definitions, so they were each based on around 60 cells. Those for establishments in multi-unit firms usually had around 440 cells for each industry. Although there were 10 firm-size classes, there could be no establishments in establishment-size classes which were bigger than the firm-size class, except for a few weird cases resulting from the use of mean size classifications when establishments were changing their firm affiliations, but these would have little impact on the results because of their small weight.

than when it is only 5 percent. Therefore the regression model is specified in terms of the natural logarithms of all independent variables. Each flow is estimated in the following form:

$$\text{flow/mean empl} = \beta_1 + \beta_2 * \text{lnage} + \beta_3 * \text{lnempl} + \beta_4 * \text{lnfempl} + \varepsilon_i \qquad (8)$$

where:

flow = job creation, destruction, reallocation, or net change;

mean empl = .5*(employment in initial year + employment in final year);

lnage = log of establishment age in years;

lnempl = log of average establishment employment for cell;

lnfempl = log of average firm employment for cell; and

ε_i is a random disturbance, which incorporates the unexplained variation.

Regressions are run separately for single-unit establishment/firms and for establishments in multi-unit firms, with the firm size variable included only for the establishments in multi-unit firms. This has two benefits – first, it avoids the problem that the average firm size is identical to the average establishment-size for all single unit establishments. Secondly, it allows us to distinguish the job flow patterns of single unit establishments (which are themselves independent firms) from those of multi-unit establishments (which may be controlled by other establishments in their firm).

As the previous analysis showed distinctly different effects of size when classified by mean size or by initial size, all regressions were run using each of these alternative methods of size classification.

C. Empirical Results

Cell-based weighted least squares regressions were run on the job flow rates (employment change/ mean employment) for each of job creation, destruction, reallocation and net change, to assist in

separating the effects of age, establishment size, and firms size. Detailed regression results for 1994-1995 employment flows for all industries together, and for three large industrial sectors are reported in Tables 5 and 6. Adjacent columns in these two tables compare the results when business size (establishment size for all establishments, and both establishment and firm size for those belonging to multi-unit firms) is classified by *initial* employment, or by *mean* employment. The exogenous employment variables are the corresponding cell averages of initial or mean employment, both for establishments and for firm size. Table 5 shows the results only for establishments that are single unit firms. Table 6 shows the corresponding results for establishments in multi-unit firms.

There are three important findings in our results, and each is stronger for the single unit establishments, which we will discuss first. First, all of the results show all *gross job flows* declining with age after controlling for establishment size. The coefficients on age are negative and statistically significant for job creation, destruction, and reallocation, regardless of the time period, the method of size classification, or the industry coverage. The linearity of the relationship of gross flows to age was explored with higher powers of age, up to the fourth power. For job creation, a model including the square and cube of the logarithm of age had significant coefficients, but only marginal increases in explanatory power.[30] The higher powers of age had no significance for job destruction.

For these single unit establishments, the negative relationship of age to gross job flows was usually stronger for destruction than for creation, so when destruction is subtracted from creation to calculate net change, the impact of age on *net job change* is generally positive and significant, but rather

[30] Plotting these estimated relationships showed that nearly all of the non-linearity was at the lowest value of age, with growth rates in the first year after birth underestimated by about 5 percentage points. The higher orders of age had the expected tiny impact on reallocation, since it is the sum of creation and destruction.

small. However, this is not consistent across industries and size classification methods.[31] This generally positive relationship of age to net employment growth was unexpected, so further explanations were sought. It could result from the assumption that the relationship is linear with the natural logarithm of age, if the relationship were actually strongly u-shaped or more complex. When this was tested, the coefficients on age squared and age cubed were found to be significant, but again, the non-linearity was limited to the youngest age group and contributed little explanatory power. Indeed, when age was completely omitted from the regression on net employment growth, there was little or no decrease in R-squared, and little change in the regression coefficients or the remaining variables. Therefore, non-linearity failed to explain the positive sign on age. Alternatively, it might be associated with the dominance of gross job destruction over creation, due to the exclusion of jobs created by establishment births, while those destroyed in establishment deaths are included. When deaths were omitted from the aggregation of establishments into cells, the resulting regressions for single unit establishments, while similar in other respects, had significant negative coefficients for age in the equation for net change.[32]

Second, all of the results show *gross job flows* declining with establishment size after controlling for age. The coefficients for establishment size are always negative and statistically significant, regardless of the time period, the method of classification or industry coverage.

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[31] The positive coefficient on age for all industries classified by mean size, and that for manufacturing classified by initial size were not significant. The small negative coefficients on age which were estimated for services (both initial and mean) were also not significant. However, for the 1990 to 1995 period, for all industries, the age coefficients were positive and significant for both initial and mean classification of size.

[32] In this analysis limited to continuing establishments – excluding deaths as well as births – the remaining gross job destruction was much less well explained (lower R-squareds), and the coefficients on age were much smaller. In the regressions on net employment change, for both single establishments and multi-unit establishments, the R-squared

The coefficients on establishment size for *net job change,* after controlling for age, vary with the method of size classification. When the traditional classification of establishments by their size in the initial period is used, size is negatively related to net change rates, and the parameters are generally[33] statistically significant. Thus, for retail and services, as well as for manufacturing and for all industries together, net growth rates tend to fall with increasing initial establishment size. However, when size is measured by mean size, the coefficient on establishment size for net job growth is positive and generally[34] statistically significant.

Third, when we examine the regressions in Table 6, for establishments in multi-unit firms, we see that after age and establishments size are accounted for, firm size differences contribute little to explaining the differences in either gross or net job flows. For all industries together, the coefficients for firm size, after controlling for establishment age and establishment size, are very small, but positive and significant for all of the *gross job flows*, except for job creation when classifying by mean firm size. These results suggest that, for larger firms, the negative effect of larger establishment size tends to be partially offset by the positive effect of larger firm size.

For *net job growth* in multi-unit establishments, the estimated coefficients for firm size are extremely small, negative, and frequently not statistically significant after controlling for age and establishment size. On the whole, these results suggest that the size of firms has little relationship to the

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values increased, and the coefficients on age (which were positive and significant when deaths were included) became negative and significant.

[33] The parameter on establishment size for net growth in the retail sector, using initial size classification, is not significant, but those for manufacturing and services, as well as all industries, have high levels of significance.

[34] The parameter on size of establishments for net growth in the service sector, using mean size classification, is not significant, but those for all industries together, and for manufacturing and retail, have high levels of significance.

net growth rates of existing establishments, after the size and age of the establishments have been taken into consideration, except to somewhat mitigate the effects of large establishments in large firms. [35]

Finally, for gross job flows, the estimated coefficients on our limited set of explanatory variables – establishment age, establishment employment, and firm employment for multi-unit establishments – were very similar for all three of the large industry sectors that were analyzed. The same general patterns held when we analyzed flows across the five-year period from 1990 to 1995, and when the general form of the function was altered (for example, using the logarithm of the change rate plus 1, rather than the rate itself). When age was not included as an explanatory variable, the coefficients on size increased somewhat, but the orders of magnitude remained the same, and the impact of firm size remained tiny.

However, through all of the variations in form of these regressions, a substantial distinction always appeared between the single establishments and the establishments that are part of multi-unit firms. Single establishments are consistently much more sensitive to differences in age than are multi-unit establishments. In the table below, the coefficients estimated for gross flows for 1994 to 1995 for all industries have been converted from coefficients on logged variables to elasticities. Each number represents the percentage points of increase (or decrease) in the associated gross flow rate that would be expected with each doubling in the level of the explanatory variable. The values are rough averages of the estimates for the two size classification methods.

[35] It appears that most of the results of analysis of growth rate differences by firm size are dependent on the close correlation of firm size with establishment size – only large firms can have large establishments, and nearly 80 percent of establishments are single-unit firms.

Estimated Elasticities for Gross Job Flows for 1994-1995

	Creation rate	Destruction rate
Single units		
Age in years	-4.8	-5.5
Establishment employment	-0.6 [36]	-0.7
Multi-units		
Age in years	-2.0	-2.3
Establishment employment	-1.0	-0.8
Firm-wide employment	+0.1 [37]	+0.1

In general terms then, comparing expected job creation rates of single unit establishments of various ages, a doubling of age will be associated with a 4.8 percentage point reduction in the creation rate. The job destruction rates of single units are even more sensitive to age. However, gross job flows in establishments which are parts of multi-unit firms are much less sensitive to age differences.

Proportional differences in establishment size have much less impact on the expect gross job flows, and the order of magnitude of these differences is similar for single establishments and multi-unit establishments. However, since the size range of establishments is much greater than that of age in years, the total difference attributable to size may be large. The relative level of firm wide employment has a very small impact on expected gross job flow rates.

The following table summarizes the regression results for net job growth for all industries for 1990-1995 and 1994-1995 job flows.

[36] Except for job creation for single units with mean classification, which showed no relationship.

[37] Except for mean classification.

Regression Coefficient Signs For Net Job Changes

	Single-unit Establishments	Multi-unit Establishments
Establishment Age	+ initial size	+ initial size
	+ mean size	- mean size
Establishment Size	- initial size	- initial size
	+ mean size	+ mean size
Firm Size	NA	0 or - initial size
		- mean size

These findings are broadly consistent with recent empirical research on Gibrat's Law. For single-establishment firms the coefficient for firm/establishment size is negative and statistically significant using initial firm size classification. For establishments in multi-unit firms, which are generally larger than single ones, there is generally a very weak or insignificant relationship between net employment growth and firm size. These results appear to be consistent with previous findings by Evans (1987a and b), Hall (1987) and Dunne, Roberts and Samuelson (1989b), that Gibrat's Law holds for large firms, but not for small firms (Caves, 1998).

The results also confirm the Davis and Haltiwanger (1998) findings that when establishment size is classified by mean employment, it is positively related to net employment growth for manufacturing. Furthermore, this is true of other major industry sectors, and for the economy as a whole. However, these results are very sensitive to the classification methodology used, and are reversed when initial employment is used for size classification. So it is not clear which methodology is more appropriate for analysis of the relationship of employment growth to business size.

V. **Summary and Conclusions**

This paper has exploited the new LEEM data to study patterns of job creation and destruction in the U.S. economy. The LEEM is an economy-wide longitudinal database covering all U.S. business locations with employees, with data for tracking multiple years of employment changes and other characteristics of each individual establishment and the firm that owns it. These data provide an unprecedented resource for exploring alternative methods for measurement of job flows. The version of the LEEM that was available for this research facilitates tracking employment, payroll, and enterprise affiliation and employment size for the over nine million establishments that existed at some time during 1990, 1994, or 1995. Thus we can also evaluate the relative impact of differences in establishment size versus firm size on expected differences in average job flow rates.

To avoid the problems of asymmetry and unbounded range in growth or flow rates calculated traditionally (by dividing change by the total number of jobs in the initial period), use of the mean of the beginning and ending period employment as the divisor for calculating rates was employed. Thus, the job flow rates can vary only from a maximum of 2.00 in the case of establishment births, to a minimum of –2.00 for establishment deaths.

Recent research on the relationship between job flows and business size has generally classified businesses by their mean size during the period over which the job flows are measured. This has been suggested to avoid any regression-to-the-mean bias in the analysis of the relationship between size and growth. However, this classification method introduces other distortions, particularly in the handling of job changes resulting from establishment births and deaths. Therefore, establishment employment flows were measured using both an initial size classification and a mean classification. For job flows between years t-1 and t, the initial year method classifies all establishment and firms according to their size in the initial year (usually t-1, but for births of new establishments it is t). The mean size method classifies

businesses according to the average of their employment in the initial and ending period, including zeros for periods when the business did not exist.

The results are, in fact, quite sensitive to the method used. The mean size classification greatly reduces the measured job creation in the smaller size classes (especially in the smallest, with 1-4 employees) relative to the initial size classification of the same job flows. At the same time, the mean size classification shifts job destruction to smaller size classes, relative to the initial classification. Under the mean size method, births of new single establishment firms are classified as half of their actual size, and deaths are similarly placed in a size class that is half the actual size of the establishment before it closed.

After examining differences in job flow rates in establishments classified by industry, establishment size, firm size, and age, we turn to multivariate methods to help distinguish the separate effects of these various inter-related factors. Regression analysis is used to investigate the direction and relative size of the relationships between employer size and age and the various job flow rates, in establishments that already existed in the initial year of each time period. Previous investigations have focused primarily on the size of each establishment, or, when it is available, on the overall size of the firm that owns or controls each establishment. The LEEM data allow the examination of each of these separately, as well as deeper analysis into which has the stronger relationship to job flow differences.

This regression analysis is used to analyze differences in average job flows in subsets (or cells) of establishments with similar characteristics, to distinguish among the effects of age, firm size, and establishment size on the patterns of job creation, destruction, reallocation and net growth. The results are summarized for each dependent variable. First, all of the results show *gross job flows* declining with age after controlling for size. When job destruction from business deaths is excluded from the analysis,

net job change is also negatively related to age. Second, establishment size is also negatively related to *gross job flows*, whether initial size or mean size is utilized. However, for *net job change* the sign of the coefficient is sensitive to the specification of the growth rate used. When net growth is classified by initial establishment size, the coefficient on establishment employment is negative, but positive when classified by mean establishment size. Yet in both cases, very little of the variation in net growth rates of existing establishments was explained by the regression model. Third, coefficients for firm size, when it differs from establishment size (for establishments which are part of multi-unit firms), are extremely small, inconsistent in sign, and frequently not significant. Fourth, the results for establishments that are single unit firms were much stronger than those for establishments that are part of multi-unit firms.

These results shed some light on the apparently conflicting findings in the literature on the relationship between net growth and size. While Davis and Haltiwanger (1998) found a positive relationship between net growth and mean establishment size, Evans (1987) and Hall (1987) found a negative relationship between net growth and initial firm size. We confirm that there is generally a positive and statistically significant relationship between net growth (excluding that from births) and mean establishment size, after controlling for age. However, using initial firm size classification reverses the signs on the coefficients for establishment size.

Caution is needed in interpreting many of these results. While growth patterns for the single year of growth were checked for consistency with those for the five-year period, the available data cover a relatively short time period which incorporates a brief recession followed by a long growth period. This may not be typical of the long run.

There are four substantial areas of uncertainty about methodology where further research is needed. First, a more adequate econometric framework is needed for handling job generation from

establishment births in a fashion parallel to that of job generation in existing establishments. Establishment deaths, on the other hand, are distributed over all age and size classes, and can be easily handled as contractions to zero employment.

Secondly, while the relationships with gross job creation and destruction are fairly strong, the specification for net growth is very weak. It appears that we can predict the size of gross flows for different classes of businesses fairly well, but we cannot predict the overall direction of net flows based on our limited explanatory variables.

Third, while the use of mean employment to calculate symmetrical, bounded job flow rates is clearly an improvement over the traditional asymmetrical unbounded rates, it is not clear that the newer method is adequate for smoothly integrating the treatment of the various types of job flows. Better methods may be needed for transforming the high growth rates associated with births and with rapid growth in very small establishments.

Finally, it is not at all clear that the use of mean size classification provides an unbiased and appropriate basis for analysis of gross and net job flows by various sizes of businesses. The extended LEEM, which will provide annual data for tracking employment in establishments from 1989 through 1996, will facilitate more detailed analysis of the potential impact of the regression fallacy, which motivated the shift to analysis by mean size.

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